

THE QUARTERLY MAGAZINE OF THE NATURAL
HISTORY MUSEUM OF LOS ANGELES COUNTY
VOL. 9/NO. 3 WINTER 1970/71

Terra



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Veracruz Exhibit exciting example of community and museum cooperation

Our Museum exhibitions are usually conceived and produced by the staff and funded through our museum budget. The current exhibit, "Ancient Art of Veracruz," is an exciting departure from that tradition, and an example of what is possible when community interest and support are coupled with museum procedures. In the continuing "fiscal squeeze" an exhibit as originally scheduled would not have been possible, and a minimal presentation unsuitable for many reasons. Therefore a meeting was called; Museum staff, the Ethnic Arts Council of Los Angeles, and members of the academic community joined to discuss the problems, and present the options, and outline a possible solution; "Ancient Art of Veracruz" is the result of that meeting.

An exhibition of such scope is always an undertaking that depends upon the generous participation of many, variously qualified individuals, and in this instance, fully aware of the responsibility they were assuming, a commitment far beyond the bounds of normal participation. The lending burden, therefore, rested heavily upon the members of the Ethnic Arts Council, the Los Angeles galleries which feature Precolumbian material and other collectors in the area. Even during the time of preparation the project swelled as the collections grew. The catalog of the show, originally "just a catalog," was expanded to fulfill the need for a definitive work on Veracruz, as usable to those interested in the artistic aspects of Precolumbian sculpture as to those of more scholarly intent.

Earthquake exhibit part of the Museum's permanent displays

How many of you know that the Natural History Museum has had an Earthquake exhibit for years? The display, in the Geology Hall, features a relief World globe constantly turning, and an aero-relief map of the World. In a display are pictures of faults and examples of the earth's crust reminding us that the dominant geological structures in Southern California are faults. A fault, of course, is a broken place or rupture in the crust of the earth along which movement occurs from time to time. We say "of course" because so much has been written about earthquakes during the past weeks that one is continually reading while absorbing aftershocks.

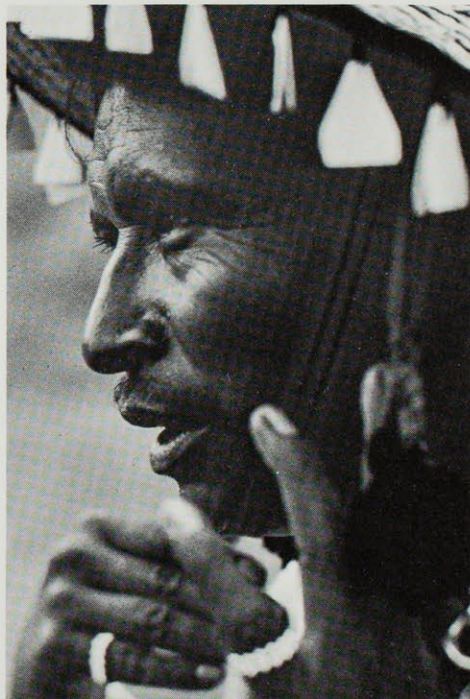
The display has now been updated to include material from our recent disaster. Prominently in evidence is a pamphlet entitled, "Safety and Survival in an Earthquake." This pamphlet is available free from the United States Geological Survey Public Inquiries Office, Room 7638, New Federal Building, 300 North Los Angeles Street, Los Angeles, 90012. Phone 688-2850.

The only damage caused by the earthquake in the Museum was to the Duckbill Dinosaur in the Great Hall. One large section of its body lies severed on the ground, giving one pause to reflect on what kind of catastrophe originally caused the gradual extinction of the species.

Ramon, famous Huichol artist, coming to demonstrate yarn paintings



The Huichols are people of the Peyote, the psychoactive cactus plant which grows in the North-Central deserts of Mexico. Ramon Medina Silva, Huichol artist, uses the combination of beeswax and colored wool to depict the sacred lore of the Huichols. A showing of his work held at the Natural History Museum in the Spring of 1969, was so successful that now Ramon and his wife, Guadalupe, are coming in person to the Museum. They will be at the Natural History Museum from April 26 to May 2, demonstrating their art and selling their yarn paintings under the auspices of the Book Store.



The Quarterly magazine of
THE NATURAL
HISTORY MUSEUM
of Los Angeles County
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Cover — Old man
wrapped in a blanket.
Clay figure unusual in
form for area of Vera-
cruz; 750-900 A.D.
11 inches tall
(anonymous loan).

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THE ANCIENT ART OF VERACRUZ

by Hasso von Winning

Clay god "Xipe Taltec"
22 inches high (courtesy
of Dr. and Mrs. Melvin
Silverman)

"It was now determined to proceed immediately to the foundation of a settlement and town, which we named De la Vera Cruz, because we arrived here on Holy Thursday [1519] and disembarked on Good Friday, and we called it Villa Rica, from the words of a cavalier, who said, 'Behold the rich lands.' " With these words Bernal Díaz del Castillo, one of the lieutenants of Hernán Cortés, relates the beginning of the Conquest of Mexico. The natives with whom the Spaniards came in contact on the coast of what is now the state of Veracruz belonged to the southern branch of the Totonac whose capital was the large urban center of Cempoalán, the modern Zempoala. A northern branch had settled in the neighborhood of Papantla where the famous ruins of El Tajín are located. Both branches were connected by a thin belt through which crossed a direct route from the Valley of Mexico to the Mexican (Aztec) garrison at Nautla. By driving a wedge into Totonac country, the Aztecs and their allies had established a foothold on the coast, and by 1463 the Totonac had become tributaries of Tenochtitlan, the Aztec capital. Consequently, the Aztec language (Náhuatl) and Totonac were spoken throughout the region.

In the 16th century the Totonac province — Totonacapan as it was called— extended from the Cazes River in the north, where it confronted the Huastecs, to the Río de la Antigua in the south, and included a large section of the eastern slopes of the Sierra Madre and parts of the highlands of Puebla.

South of the Totonacapan resided Nahuatl-speaking peoples and the section bordering Tabasco was occupied by the Popoluca, who belong to the Mixe-Zoque linguistic family. The latter were probably descendants of the Olmec, who had created the first civilization of the New World.

The modern state of Veracruz is characterized by great environmental and climatic contrasts. The coastal lands are hot, humid, and partially swampy. Ascending towards the foothills of the Sierra Madre is a savannah-type, semi-arid zone where important Early Period settlements have been located (e.g. Remojadas). The eastern slopes of the massive mountain chain rise abruptly to about 9000 feet where

a cold and moist climate prevails.

The "rich lands" on the coast, which caught the eye of the Aztecs and then of the Spaniards, were at times well populated and intensively cultivated, producing various crops, especially cotton.

For archaeological purposes, the location of the major Prehispanic cultures has prompted a tripartite division of the state into North, Central, and Southern Veracruz.

In the north of Veracruz flourished the Huastec culture, which extended into Tamaulipas and San Luis Potosí. Not far to the south, in Totonac country, is Papantla, then and now famous for its cultivation of vanilla, and nearby, the vast site of El Tajín. Its nucleus alone covers 164 acres of pyramids, palaces, temples and terraces, including the renowned Pyramid with the 364 niches. The wall panels of the two ball courts and the drums of the Building of the Columns depict carved designs of winged dancers, Eagle Knights, scenes of human sacrifice, and calendric symbols. El Tajín, which was first described in 1785, was the seat of the northern Totonac and reached its peak in the 10th and 11th century A.D. The word means "lightning" and is the name of an important rain deity.

The extent of Central Veracruz has been defined by H. B. Nicholson as reaching from the Sierra de Chiconquiaco (to the east to Tlacolula) to the Tuxtla Mountains. This is the area where most of the sculptures in this exhibition originated. Since it is mainly south of the Totonacapan it would not be entirely correct to refer to these sculptures as Totonac.

Southeastern Veracruz, which merges with Tabasco, constitutes a 60 mile deep coastal archaeological area which is limited by the headwaters of the Rio Blanco and the Laguna de Alvarado, and in the east by the Grijalva River. To some extent this low-lying tropical zone merges with Central Veracruz. M. D. Coe described it as one of the richest archaeological zones of the world and one of the densest conglomeration of archaeological sites. Southern Veracruz and adjacent Tabasco is the heartland of Olmec civilization.

Beside the areal subdivision, it is necessary to consider the cultural

development on a time scale. In broad terms, the era preceding the efflorescence of the great urban and religious centers of Teotihuacán, Monte Albán and El Tajín, is sometimes called the Formative but, preferentially now, the Preclassic Period which, ranging from 2000 B.C. to 100 B.C. can be subdivided into Early, Middle and Late phases. It is followed by a transitional period, the Protoclassic (100 B.C.-A.D. 250). During the ensuing Classic Period, the Early Classic phase (A.D. 250-550) was characterized by the flourishing and far-reaching influence of Teotihuacán, followed by the collapse of this urban civilization in the early part of the Late Classic (A.D. 550-950). The upheaval caused by invasions of northern nomads and the rise of the Toltec empire are the keynotes of the Early Postclassic (A.D. 950-1200), which is followed by the Mixteca-Puebla horizon and Aztec expansion in the Late Postclassic until the total collapse of the New World cultures in the early 16th century.

With these geographic and temporal subdivisions in mind, let us briefly consider the ceramic art which, for the main part, originated in Central Veracruz during the Classic period, and to a smaller extent during the Late Preclassic and the Postclassic.

Among the remarkable achievements of Precolumbian art are the clay figurines, representing humans and animals, which occur in untold quantities throughout Mesoamerica. Those made by the early villagers are small, often miniatures, and are entirely modeled by hand. The finest examples were produced by the Middle Preclassic Olmec culture: the so-called baby faces and the pretty ladies of Tlatilco. In the Classic period figurines were cast from press molds, either completely or only the heads were molded and attached to a handmodeled body. During the Postclassic, moldmade figures declined both in number and in aesthetic quality.

Although an enormous amount of figurines has been recovered, their function is, with some exceptions, still enigmatic. Obviously, during the thirty centuries of Precolumbian civilization, the art of figurine making varied from region to region and period to period. George Vaillant and Miguel Covarrubias have shown that the wide range

of Preclassic figurines from the Valley of Mexico can be fitted typologically into an evolutionary sequence that resembles a family tree. Likewise, the figurine types of the various cultures of Veracruz reveal a progression, determined by the modeling techniques, headaddresses, facial features (especially the eyes), dress, ornaments, and paraphernalia, all of which reveal a relationship that, however tenuous, gives the figures a characteristic Gulf Coast flavor. The sequential development did not necessarily proceed from the naturalistic to the abstract, nor from the simple to the complex. It is evident, however, that the most ornate and overburdened pieces are likely the terminal products of a culture period. After that, new forms were created or introduced by trade or conquest. Regional variations in design coupled with a strong conservatism for earlier established patterns give the figurines a distinction by which they can be recognized as part of the Pan-Mesoamerican tradition.

The ceramic sculptures are distinguished by their large size, by their posture and gestures, their facial expressions, and their elaborate dress and ornaments. The range in size, from 2 to 35 inches, implies that methods in handling clay and in controlling firing temperatures had been well mastered. Wide rectangular openings in the back of the larger figures — the former being a diagnostic of the Veracruz style — prevented the figures from bursting during firing.

Posture varies according to type. For instance, smiling figures are almost invariably free-standing, holding up their arms in a suppliant gesture. Hands and fingers are expressive, often graciously extended. Objects, such as rattles, trophy heads pending from a sling, etc., are held in a realistic manner. Aggressive weapons are infrequent, but shields, round or rectangular, occur more often. Seated figures are portrayed crosslegged, tailor-fashion, whether male or female.

The variety of facial expressions is perhaps the most remarkable aspect in Veracruz art. In early period figurines, eyes are marked by simple depressions, or incised with punched pupil, or simply buttons of clay painted black (the use



Decorated clay flute
14 inches long (courtesy
of the Stendahl Gallery)

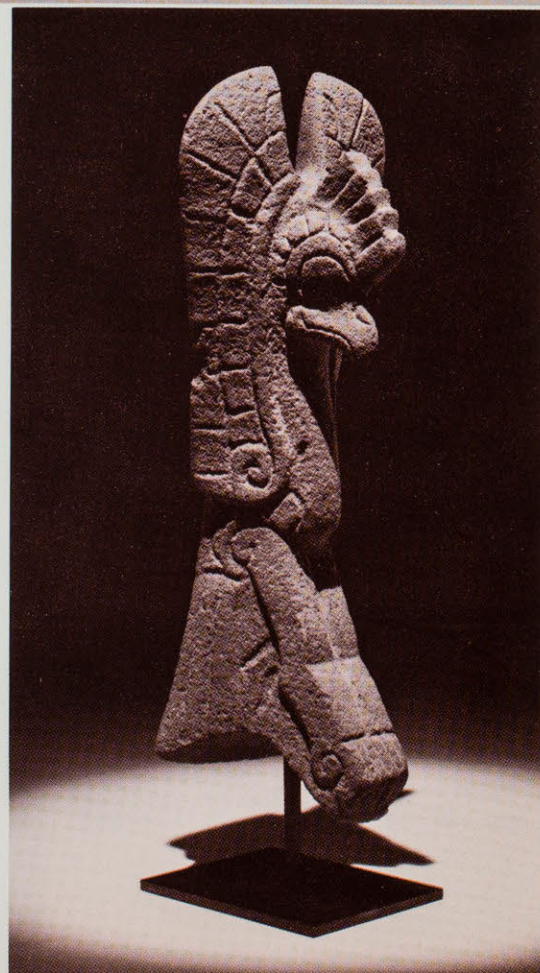
Seated clay figure in
elaborate costume 13.5
inches high (courtesy of
Mr. & Mrs. Vincent Price)





Painted clay "bed figure"
10.5 inches high (cour-
tesy of Mr. & Mrs.
Jules Berman)

Stone Quetzal bird
"palma" 17 inches high
(courtesy of Dr. & Mrs.
George C. K. Kennedy)



of resinous shiny black paint is also a Veracruz diagnostic). Although numerous techniques in modeling the eyes were employed, the faces lack expression, but they provide a useful method by which the figurines can be classified chronologically. In Classic times again a wide range of facial expression is represented: from the commanding, serene and placid countenance to the supple contented smile and the almost idiotic grin at the other extreme. Cheeks and the open mouth underscore the mood. The front teeth were filed down leaving only the upper two incisors in the middle. One wonders how this custom might have affected the speech of the people who these figures portray.

The garments, shown in paint or in bas-relief, are indicative of highly developed weaving and embroidering techniques. The loincloth, a traditional Mesoamerican male garment, often has a long decorated flap in front which also occurs in other areas, particularly among the Maya. Females wear skirts with a lateral flange and the ladies with the smiling face display an embroidered strapless breast band, which was not customary in any other part of Mesoamerica. Surprisingly, it is also worn by individuals in loincloth. Sandals are shown occasionally and consist of flat slabs tied with thongs.

It cannot be ascertained whether all of these figures represent persons of rank; those with elaborate ornaments certainly do. Some of them hold rattles and are probably dancers. On the whole, one gets the impression that these people enjoyed fine clothes and ornaments of carved jade and shell, and in some cases they freely expressed their emotions. This aspect of Veracruz art contrasts with representations from the Central Highlands, Oaxaca, and the Maya area where the figurines usually portray stern, impassive individuals.

H. B. Nicholson has discussed those figures which represent deities or their priests, and he points out that "the Gulf Coast from the onset of the Classic period and perhaps even in the Preclassic, shared many pantheonic and ritual patterns with the contemporaneous Central Mexican religious system, much of which apparently survived relatively intact until the time of the

Conquest." Consequently, and on the basis of iconographic similarities, one can recognize in this collection representations of such well known deities as the Old Fire God, of rain-fertility gods, and the Flayed God and Goddess (Xipe). The Fat God, derived from Teotihuacán, is quite common until the end of the Classic, when some of his functions were taken over by the Xochipilli-Macuilxochitl cult. Figures with death symbols personify the Lord of Death or supernatural beings with mortuary connotations. The emergence of a wind-fertility god, and aspect of Quetzalcoatl known as Ehécatl in the Postclassic Mixteca-Puebla iconographic system, appears to be represented, according to Nicholson, by some prototypes as indicated by various forms of buccal masks. Although similar occurrences on sculptures from Oaxaca come to mind, the Veracruz portrayal of the buccal mask probably is the immediate prototype of the Postclassic Ehécatl mask.

The smiling figures, mentioned earlier, might be antecedent to the Postclassic Macuilxochitl cult. Doris Heyden links these figures with decapitation rites since many were found without bodies from which they had been intentionally severed.

In attempting to find an answer to the obvious question concerning the function of these clay images, Nicholson noted that many appear to represent ritual performers, and he concludes that, at least in Postclassic times, the Veracruz area participated in the well-developed idol cult which is typical for Western Mesoamerica in general.

Harold W. McBride has established a tentative correlation of figurine types and cultural phases, based on often contradictory excavation reports. He outlines the diagnostic features of two long lasting traditions: that of Remojadas in north-central Veracruz and the Nopiloa tradition of the Rio Blanco-Papaloapan region.

A peculiarity of these ceramic traditions is the frequent occurrence of whistle-figurines, that is, without being a musical instrument *per se*, the figurines contain a whistling device and a mouthpiece. The latter is incorporated either on the top of the head or on one side, or in the rear support, similarly as

in the figurines from the Campeche coast (Jaina).

As José Luis Franco stated, Central Veracruz shows the greatest diversity on musical instruments in all of ancient America during the Classic period. Some of the remarkable qualities of these instruments are discussed in his article in this catalog. We shall here point out only one extraordinary type containing a free piston, formed by a clay pellet, and for which Elizabeth Waldo coined the term "slide flute." Tilting the instrument changes the length of the air duct and produces a kind of glissando. In addition, these flutes are elaborately decorated and a figurine is sometimes attached to them.

Before concluding this resumé of ceramic art, a word on the pottery is in place. It was mentioned earlier that because of its geographical location the area of South-central Veracruz received stimuli from the Mexican Highlands and the Maya area. Such manifestations are evident in some of the figurines but also in a group of intricately decorated bowls which were made from two molds and which depict religious and secular rituals. Both the modeling technique and the iconographic contents reflect influences from abroad.

Finally, we must refer to a group of portable stone sculptures which are sometimes labeled Totonac but are of Classic Central Veracruz origin. Stylistically related to the Tajín reliefs with their characteristic scroll work, they include yokes, figural stone blades called *hachas*, and finials generally known as *palmas*. Of these, the thin crested heads, which are probably symbolic of human trophy heads, may be early forms of the *hachas* and *palmas*. A stylistic sequence of this sculptural complex has been elaborated by Miss Proskouriakoff (1954) and accordingly, it is reasonable to assume that in time the sequence exceeds the beginning and end of the Classic period. That the sometimes plain, but mostly ornate yokes and *palmas*, and the tenoned crested heads were part of the ball court paraphernalia is shown on the Tajín reliefs as well as in some of the clay figurines. The thematic variety of the designs in these sculptures is remarkable. The yokes were carved

mostly with animal representations, but human figures occur likewise. In George Kubler's words, the body features are disjointed and reorganized to advantageously fit the form of the yoke. He also suggested that the thin *hachas* may have been personal symbols of a heraldic character, designating individuals or teams. *Palmas* have a concave base to fit upon the yoke and a broad fan-shaped finial whose complex designs may also symbolize personal emblems. The former were less widely distributed, whereas the yokes and *hachas* were discovered in such distant places as Teotihuacán, Oaxaca, Guatemala and Salvador.

Our brief survey of the sculptural art of Central Veracruz can only bring into focus the more outstanding features which were created in this area and which contributed so significantly to the splendor of the ancient civilizations of Mesoamerica.

Hasso von Winning published numerous articles on Mesoamerican archaeology and is Contributing Editor for the Handbook of Latin American Studies. He is the author (with Alfred Stendahl) of "Pre-Columbian Art of Mexico and Central America" (Abrams 1968). A long-time resident of Mexico, where he studied archaeology and participated in excavations, he is now Consultant in Mesoamerican Archaeology for the Southwest Museum at Los Angeles.

SUGGESTED READINGS

- Ancient Art of Veracruz. 1971. Catalog of an Exhibition at the Los Angeles County Museum of Natural History (with articles by H. B. Nicholson, Jose Luis Franco, Harold McBride, Hasso von Winning, Doris Heyden, and Sage Culpepper Belt).
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MAP OF THE GULF COAST AREA

- (N) Northern Veracruz
- (C) Central Veracruz
- (S) Southern Veracruz

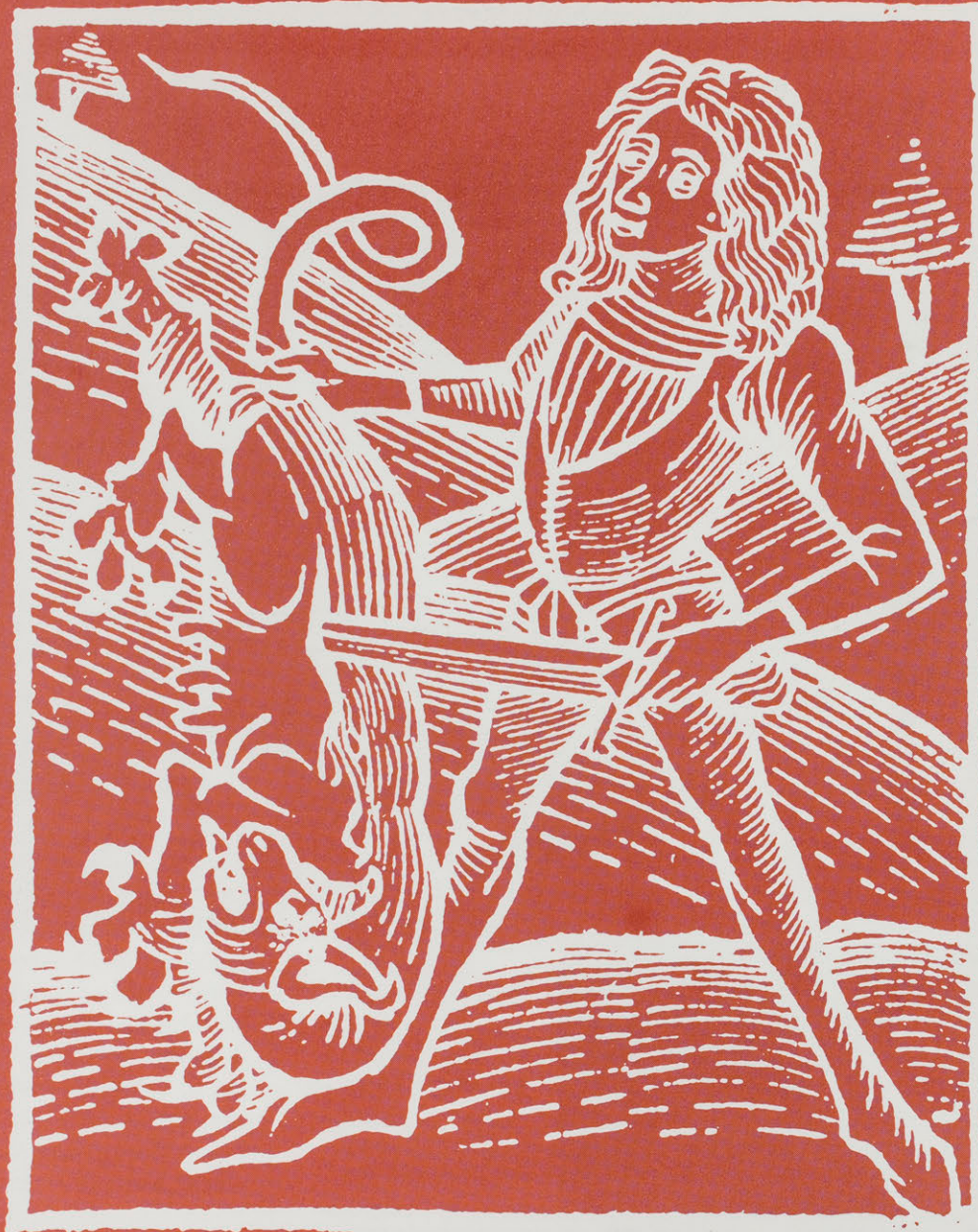
Adapted after M. Covarrubias.



Clay monkey on a
wheeled cart 6 inches
high (collection L.A.
Co. M. N. H.)

Clay figure with smiling
face 17 inches high
(courtesy of Dr. & Mrs.
Ernest Fantel)

Woodcut of a slain dragon from de Cuba's *Ortus Sanitatis*.



DRAGON'S BLOOD

by William A. Emboden Jr.



A *Dracena draco* photographed in Ocean Park, Santa Monica, California.

In antiquity, the most potent philtre for conjuring was the blood of a dragon. Legend states that there is a tree which grows from the grave of the sea monster, *Pau Tangalu*, which bleeds drops of the monster's blood. So potent is this blood, that if burned by a deserted wife or lover near an open window for seven midnights, it will bring the deserter home.

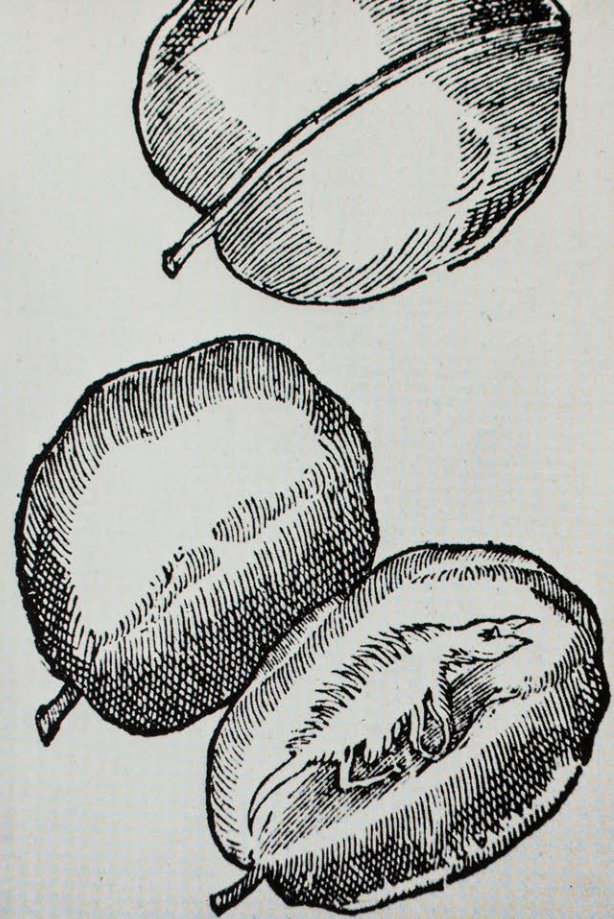
Dragon's blood was said to be the blood of the great dragon called Basilisk by Pliny. Born of the unfertile egg of a black hen, and one without a yolk, the Basilisk was a magical creature who could destroy serpents with its breath, burst boulders, scorch grass and exercise dominion over herbs of the land. Moreover, according to the Magi who had the secrets of holy oils and healing herbs, if one were to burn the blood of a Basilisk a satisfactory resolution to one's petitions could be wrought. A prayer accompanied by the censer's fumes of burning dragon's blood could disarm any sorcery with which one might be afflicted. Like the blood of the lamb during Passover, dragon's blood put on a doorpost would keep the tenant's house free from harm during periods of crisis.

Philostrati in his *Vita Apollonii* (Lib. iii, cap. 8) tells his readers how to procure the true dragon's blood. One must weave a cloth of scarlet and upon it embroider mystical letters. Place this before a dragon's den, and when he emerges he will become mesmerized by the enchanter's mystical letters and fall into a stupor permitting him to be slain. In addition to the valuable blood, there are reputed stones in the head which have the remarkable property of rendering a man invisible.

The first representation of dragon's blood is to be seen in a copperplate engraving by the famous German engraver of the 15th century Martin Schongauer. This masterpiece of engraving entitled *The Flight Into Egypt* was executed between the years 1469 and 1474. It is a curious thing that at this date, when the source of dragon's blood was known but to a few, Schongauer shared this secret. Evidence for this comes from a careful depiction of a wound on the trunk of the tree, just above two sun lizards, from which a bloody resin is oozing. It would seem that this tree was being used for its symbolic import; the dragon, being a symbol of evil, is portrayed as one of the trees in the forest

from which the Holy Family is emerging on their flight into Egypt. Deliverance seems manifest in the cherubim which bend a date palm so that Joseph might collect some fruit. The reputation of dragon's blood having come from a slain dragon makes the allegory of triumph over evil implicit in the figure. The portent of Christ's suffering in the use of this wounded tree may provide a double symbolism. That Shongauer was aware of the use of such symbols is apparent in his choice of the muellin plant at the rear flank of the ass; this herb was known as "Our Lady's Candle" and is symbolic of the unflagging devotion of the Holy Mother.

That physician and chronicler of Seville in the 16th century, Nicholas Monardes, tells of his encounter with dragon's blood in a book printed in Seville by Hernando Diaz in 1569. This tome bears a 46 word title, and the expanded edition published in 1571 carries a title of 111 words — surely unequaled in the history of printing. In 1574 Monardes had the two volumes published as one, owing to the enormous popularity of his writing on the marvels of the "New World". Most of these two volumes were Englished by



the merchant John Frampton and printed by William Norton at London in the year 1577 under the abbreviated title *Joyfull Newes Out of The Newe Founde Worlde*.

Monardes tells of an encounter with the Bishop of Cartagena, a seaport city of southeast Spain, who he assures us is "most religious and learned, and very curious in things". The good Bishop apprised Nicholas of owning the fruit of a tree from whence was taken the blood of the dragon, whereupon he took from his pocket a leaf and unfolding it revealed a dragon. Monardes regarded the creature with awe, but stated that it was counterfeited. He records his impressions thusly:

"... he did seem as though that he had been alive, having a long neck, the mouth open, the bristles standing up like thorns, the tail long and standing upon his feet. No man which shall see him will not marvel at this figure... no craftsman could make it more perfect."

As the first edition of *Joyfull Newes*... was without woodcuts, save for one of Monardes himself, only readers of the later volumes were treated to a curious woodcut showing three "fruits;" one of which bears the likeness of a

most peculiar dragon. The beast has more semblance to a hyena which has had an encounter with a hedgehog. The "fruits" were probably counterfeited by forming a ball out of the resins of a tree known as a "dragon's blood tree". Nicholas Monardes was not a gullible man and did indulge those who were. He speaks of his colleagues, "the new writers", as "following the same ignorance (of earlier writers) as they are wont to do of things that are of a questionable nature". He says that they have nothing new to say except in those things that are perfectly clear to any man. When he refers to the Greek, Latin, and Arab writers of an earlier date he refers to their "thousand desperate sayings" and diverse judgements.

Certainly when referring to blood of the dragon, his criticisms were just, for the tales told by ancient writers regarding the source of this potent material attribute it to a dragon whose throat was slit, the blood of a strangled elephant, the juice of the herb *Cideritis*, the juice of an herb known as *Draconito*, and "many other vanities". Monardes tells us that time is the discoverer of all things, and that time has revealed the tales of the ancients to be mostly

false. The truth is that "dragon's blood comes from a tree of much greatness which, as a result of incisions, casts forth blood drop by drop", affirms the physician of Seville.

Monardes' appraisal was approximately correct, and while he discounts many of the attributes ascribed to this tree, he correctly assigns some of its virtues as a medicine and recognizes the blood to be a resin.

The first illustration of this fantastic tree in a botanical work appeared in the *Rariorum aliquot stirpium par Hispanias observatarum Historia* published by the Plantin Press in 1576. Jules-Charles de l'Ecluse, who adopted the Latin name of Clusius, wrote this volume after several years of naturalizing in Portugal and Spain. Although Clusius was Flemish by birth, having been born in Arras in 1526, he mastered six languages at an early age and was proficient in eight disciplines by the time he finished his university training. Oddly enough, botany was not among those things which attracted him as a student. It was not until he left for Montpellier and came under the influence of Guillaume Rondelet that his eyes were opened to the fascinations of the plant world. Rondelet is remembered not so much for his

An early woodengraving of the dragon tree of Ténériffe as it was seen by Bertholet in 1819. Note the repair work inscribed 1819.

The woodcut which appeared in the second edition of Monardes *Joyfull Newes* showing "fruits" of the dragon tree as well as the dragon.

The Flight Into Egypt as engraved by Martin Schongauer around 1470.

The tree at the left margin is the dragon's blood tree.



surviving works as for his greatness as a teacher, having schooled a number of the greatest men of his day. Because of his facility with languages, Clusius had a tendency to speak to the exclusion of writing and the early writing that he accomplished was a series of translations of other authors, including the venerable Nicholas Monardes whose works Clusius translated out of the Spanish and into Latin so they might be available to a greater number of scholars.

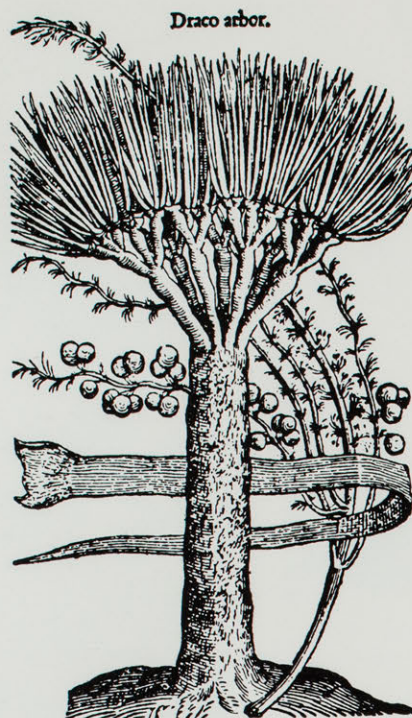
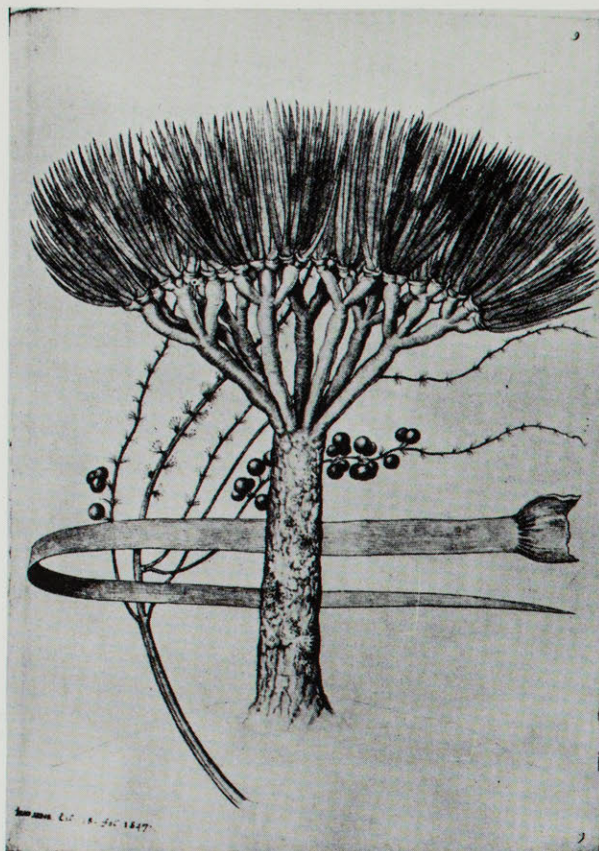
While in Lisbon with two students, Clusius was invited to visit the monastery garden of Santa Maria a Gratia where he encountered a tree which he had previously read about in the writings of Monardes—the fabled dragon's blood tree. So impressed was this emergent botanist with the "Draco Arbor", as he called it, that he commissioned the famed botanical illustrator Pierre Van der Borcht to execute a watercolor after which a wood block could be cut for printing. Fortunately, the original watercolor is preserved in the Clusius Collection in the Preussische Staatsbibliothek in Berlin (Libri picturati, A 16-33 libro 18, folio 1847). The woodcut made from this painting appears as figure 117 in Clusius' *Rari-*

orum . . . etc., the first volume which he produced that was not a translation of another author's work.

Webb and Berthelot, in their *Natural History of the Canary Islands*, tell of the subjugation of the inhabitants of the city of Ténériffe in 1496. The natives of Orotava (formerly Orotapala) were the Guanches about whom little is known. One fact however is manifest in this account of Orotava, the Guanches regarded the indigenous dragon trees as their protectors and venerated them, for these were thought to have a soul. The origin of this belief may lie in the bizarre characteristics of a single tree which Alexander von Humboldt saw in 1799 and at that time estimated to be 6000 years old! This estimate seems a bit exaggerated, but Lindley writing in *The Vegetable Kingdom* records notes made on the tree in 1406 on the condition of the tree in that year and states that it was even then regarded as ancient. An equally impressive description of the dragon tree of Ténériffe came from Bertholet when he visited in 1819. He concurred with von Humboldt in the measurements of the monster being 45 feet in circumference and 75 feet tall, but by the time of his arrival a hurricane earlier that year had torn

away one large piece of the giant. When Berthelot arrived at the peak of Ténériffe he entered the gardens of La Casa Franchi to find "un dragonier" facing him among the more pedestrian hedges of roses and myrtle. Half concealed in the enormous trunk was a rustic door by which one could enter the cavity which had eroded away with the centuries. "Ten men could be accommodated within the hollow trunk without discomfort," Berthelot records. Long sword-like leaves crowned this monster, and great panicles of white flowers framed against the sky made the effect all the more startling. The storm which had leveled almost all other trees in the area had only torn an arm from the "dragonier" leaving a hole which was repaired by implanting a cement plate to prevent the infiltration of water and attendant organisms of decay. The date of the storm, 1819, was inscribed thereupon.

Within the interior of this tree, and other members in the area, excrescences of resin appear which may accumulate to the size of coconuts and are of a translucent garnet red color. The decay of the interior of the trunk is a regular phenomenon in older trees and the natives of the Canaries used this



Watercolor attributed to Pierre Van der Borcht in the collection of the Preussische Staatsbibliothek in Berlin. Draco Arbor.

Woodcut from Clusius' 1576 volume on plants of Spain and Portugal made from the watercolor of Van der Borcht.

secreted resin to advantage. Masses of dragon's blood were collected by the Guanches and carried to caves where they used the material to embalm their dead, just as the Egyptians used the resins of myrrh and balsam in similar rituals.

Given these observations, it is no wonder that one of the historians of the island drew from his classical background to metamorphose the dragon tree into the Dragon of the Hesperides who was guardian of the golden apples. This, of course, added to the already fantastic tales being concocted about dragon's blood served to keep the market price very high in Europe. Those who arrived to exploit this resource found that the "blood" could be collected by wounding the plant and allowing the exudate to accumulate and harden around the injured area. It was probably just such a mass, resembling the apples of the Hesperides, that was presented to Nicholas Monardes as a "fruit" of the dragon tree. There can be little doubt that skilled artisans in Europe were busy shaping the excrescences into miniature dragons that would form the staple of witchcraft as well as medicine; one must remember that medicine was born of alchemy, witch-

craft, magic and herb lore. The alchemist and physician Paracelsus was one of the first to bridge the gap between magic and medicine. The doctrine of signatures proclaimed that by the will of God every tree and herb would reveal in its parts the use for which the Creator intended it in the service of man. Could there be any doubt then that the dragon's blood was empowered with the ability to allay the flow of blood in wounds and hemorrhage? And in this capacity it was demonstrable efficacious. As an internal medicine it was credited with powers which are not so readily demonstrable. As to its ability to return an errant lover to his beloved, we need not speculate.

The popularity of the resins of *Dracena draco* was not occluded by the many other plants which were also utilized as sources of dragon's blood. In addition to the aforementioned, *Dracena cinnabari*, thought to be dragon's blood of the ancients was regularly brought from Socotra and imbued with limitless virtues. *Dracena schizantha* of East Africa and South Arabia produced "Arabian dragon's blood." Another plant, the vine *Pergularia africana*, native to tropical Africa as one of the indigenous members of the milk-

weed family, was known as dragon's blood also, however, the latter served primarily as an adulterant of the resins obtained from the *Dracena* species. Among the palms both *Pterocarpus draco*, a West Indian species known in that area as 'Padauk' and *Daemonorops draco*, a Sumatran palm, produce resinous exudates. The latter was sold under the name 'resina draconis' revealing a little more honesty than the more frequently encountered epithet 'sanguis draconis.' *Daemonorops* has a fruit the size of a cherry from which the resins appear as ruby-colored scales. In Guiana the genus *Dalbergia*, which includes a host of trees producing exotic cabinet woods, produces a dragon's blood which is fragrant enough to be used as incense in Chinese and Hindu temples. Mexicans have long used 'sangre de draco' from a native spurge, *Croton draco*, as a cure for hoof diseases of horses as well as employing the bloody exudates as a dye for fabrics. A wounded *Croton* produces an abundance of the 'sangre.' Australia entered the market rather late with a red gum from *Eucalyptus resinifera* which appeared on the market under the names 'kino' and dragon's blood. "Chinese Colli" is a name which has

Dragon's blood from
Dracena draco.



been used to describe the resin of *Dracena terminalis* which was used in China for centuries to obtain the fine blood-red stain seen on their lacquerware and the root was used to make an intoxicating beverage which had the additional attributes of stopping dysentery and diarrhoea.

Malaysian dragon's blood is that which is most frequently found on today's market and may be found as a blood-colored rod wrapped in a palm frond and usually stamped with a red horse emblem. Three species of *Dracena* are used in making this material, hence it is of inconsistent quality. *Dracena didynophyllos*, *D. micranthus* and *D. propinguus* are all ingredients of this product.

Dragon's blood smeared upon heated marble will penetrate the stone giving it a deep red color which is characteristic of some of the marble seen in the tomb of the Medici Princes in Florence. Not only did the Florentines prize the "blood" for coloring marble, but an early Italian formulary gives this account for the treatment of syphilis:

"Mix 2 drachms of Dragon's Blood, 2 drachms of colocynth (*Citrullus colocynthus*) and one half ounce of gamboge (*Garcinia hanburyi* resin) in a

mortar, and add 3 gills of boiling water. Stir for an hour. When cool, add while stirring a mixture of 16 drachms each of sweet spirits of nitre and copaiba balsam (*Copaifera* sp.)"

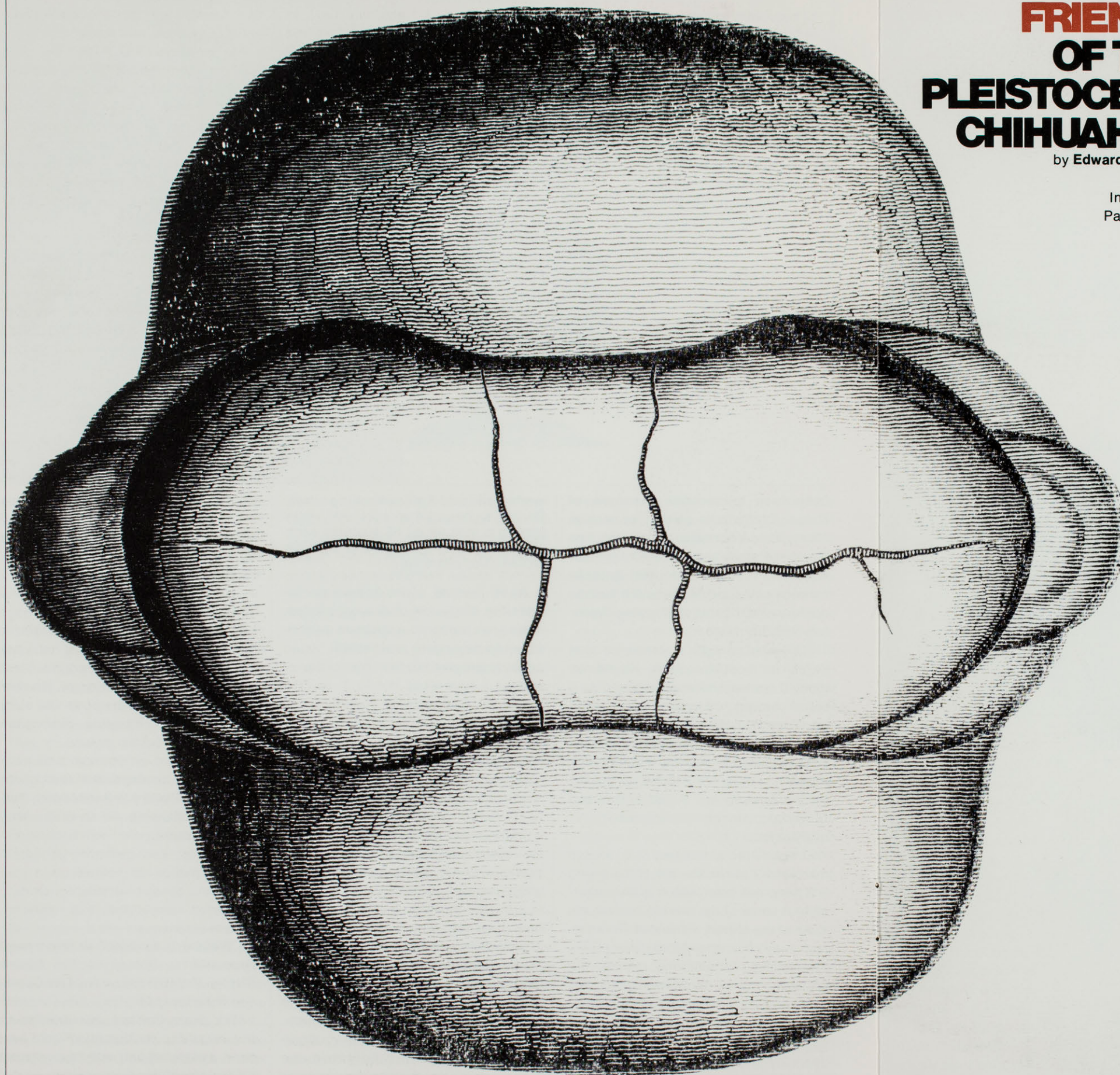
Apart from all of the hoaxes perpetrated in the name of dragon's blood, it did for a time find a place as a dentifrice, an astringent mouthwash, as an agent to prevent the free flow of blood, and as a heal-all in the form of "red plasters." The resin of *Daemonorops* in particular found a considerable use as an antimordant in etching and photo-engraving. Perhaps the most important use to which this resin was put was that of forming a very fine varnish which the finest Italian violin makers of the 18th century used on the wood of these instruments. The tone, color, and longevity of these instruments, many of which are still in use today, owe their fine quality to the dragon's blood varnish covering them. These formulae are as much a mystery as the certainty of the source of some of the dragon's blood used.

Once a rare commodity from the Island of Orotava, dragon's blood has fallen into obscurity. However, along the streets of southern California one may occasionally spot the descendants

of these monsters of the Canary Islands, their sword-like leaves in coronas against the sky and pendant panicles of orange fruit, the size of cherries, dropping to the ground. None of these is as impressive as the monster at Ténériffe, but perhaps with some imagination you may recall the red glazed mummies of the Guanches, or smell the faint fragrance of dragon's blood burning by an open window, or even hear the faint sonority of an old violin still encased in its glaze of dragon's blood.

Note: I wish to thank the staff of the Huntington Library in San Marino, California for allowing me to utilize their fine collections.

Dr. William A. Emboden Jr. is research Associate in Botany at The Natural History Museum of Los Angeles County and Professor of Biology, San Fernando Valley State College. His articles for this magazine on Narcotic Plants have been expanded and will be published by The MacMillan Company.



FRIENDS OF THE PLEISTOCENE CHIHUAHUA

by Edward C. Wilson

Curator of
Invertebrate
Paleontology

It's all part of being a curator in a public museum. I mean, you have to know your own special field cold and also some unrelated crafty pseudo-sciences like practical psychology and all the while hold onto your humor.

For instance, take the humor.

A lady recently brought in — more for admiration than confirmation — her fossil chihuahua. She was dead serious as she demonstrated each of his once vital parts, from pooky nose to tail petrified in mid-wag.

And now, take the psychology.

In the interest of honesty, it seemed desirable to try and explain to her that she had — albeit doggy handsome — what Reid MacDonald succinctly termed in the Spring 1968 Quarterly a “concretionary mass of naturally cemented sand” and not a fossil at all. It was a concretion.

Well, her fossil chihuahua was her fossil chihuahua and who did we think we were, young man, to question something so obvious that no one had ever questioned it before, including her son-in-law, who was an expert on such things and, incidentally, had a particularly fine fossil turkey hen. You cluck.

And she wagged out in mid-humpf.

Well, that's the way it goes sometimes. I admired that lady for her true grit. And I liked her half-wagged dog. Let me introduce you to some of his friends, many of whom are just dying to be adopted, and tell you some of their stories.

Concretions are boogaloo things, there's no doubt about that, although there's fair doubt about much else concerning them. Very clever geologists are working on these problems, however, so don't you worry. They've already worked so hard that they've found out that concretions are formed in several ways, so they don't even want us to call them all concretions any more, but better names, like “accretionary structures”. This simply means that they all grew somehow. It's this bully somehow that bothers the geologists so much that they use other special names for what they imagine to be all the various kinds, based on how and where they think they grew.

They have made several categories for their accretionary structures. Among those most commonly brought

into the museum because they look like fossils are “true” concretions, nodules, geodes, and septaria.

Are you still with me? Push on.

“True” concretions have a concentric structure. They are usually roundish, or maybe shaped like a flying saucer, or maybe shaped like anything or nothing that you ever saw before. If they are too close while they are growing, they will coalesce. This is how the chihuahua was formed. They can be as small as this “O”, as museum friend Harriet Huntington is fond of saying in her fine children's books, or as big as a balloon gondola. Sandstone and shale are the rocks that most often have true concretions and you can usually observe that the bedding planes of the rock pass right through the concretions. This means that they must have formed after the rock accumulated. The concretions and the host rock have the same kinds of sand or shale grains in them, but different kinds of cement holding these grains together. Silica, calcite, and iron oxide are common cements in concretions and these usually form so as to make the concretions harder than the host rock. Therefore, the host rock weathers away more rapidly and the concretions are left sticking out of it or lying around on the surface.

Some true concretions formed about nuclei, often real fossils of some kind, and when they are broken open these may show. The fossil may be identifiable, like a lovely fern, a shark's tooth, a crab, or a seashell. But it's the outside shape that concerns us here.

Surely the most famous true concretion in Los Angeles County was the one known to our museum staff as “the giant clam of Malibu.” Many people seemed unshakeably convinced that it really was a clam and about once a month one of them would get on the blower to report its existence. Once a gentlemen demanded in a wavering voice that I save it.

“Save the giant clam,” he said, “save, bless you.”

At least I think the cat said bless.

And he hung up.

This big concretion was about 8 feet across and it did look kind of like a clam, as you could judge for yourself if you looked up in the sandstone cliff



Museum volunteer field assistant Larry Walters admiring some big concretions we found outside a rock shop in Overton, Nevada.

on the Coast Highway just south of Sunset Boulevard.

From time to time, local newspapers published pictures of it being "discovered" by school-children. But — alas — the last time I looked it was gone. Hats off as you drive by now. But then again, maybe somebody just saved it.

So the "giant clam of Malibu" was not a fossil. Neither are the concretionary "punkins" in the Punkin Patch near Tule Wash in the Anza-Borrego Desert State Park of southeastern California. This park also has fantastic piles of big concretions which may be seen there in the San Felipe Hills. South of the park near the Mexican border, concretions like marlin spikes have been found. Much of the city of San Diego is built upon another sandstone formation that has many delightfully shaped big concretions. I once met a gentlemen there who had made a collection of them and thought that they were fossil remains of a race of giant people. He had an especially convincing "ear" that was about two feet high.

The bigger concretions are great things for just sitting around on the

patio or in the garden, but I wouldn't recommend certain shaped ones if you have a prudish aunt who is remembering you in her will.

A special kind of concretion seems to form in some fresh water swamps and lakes. These usually form about a nucleus that may be a beautiful fossil. The famous Mazon Creek concretions of Illinois are known especially because of the plant fossils inside. In the Calico Mountains of San Bernardino County in southern California, tiny but magnificently preserved insects are preserved in the centers of concretions. In many, even the lenses of the eyes and the hairs on the bodies have been retained in their original shapes.

On the north edge of Las Vegas, there are some freshwater lake bed sediments in the middle of the valley near the road to Tule Springs Park. These have simply fantastic little animal cracker like concretions. They are very abundant in some beds and collecting and identifying them is enormous family fun.

Nodules are another kind of accretionary structure. They are usually irregularly shaped and may look like

Concretions from our museum's collections, all shown slightly smaller than the actual specimens.

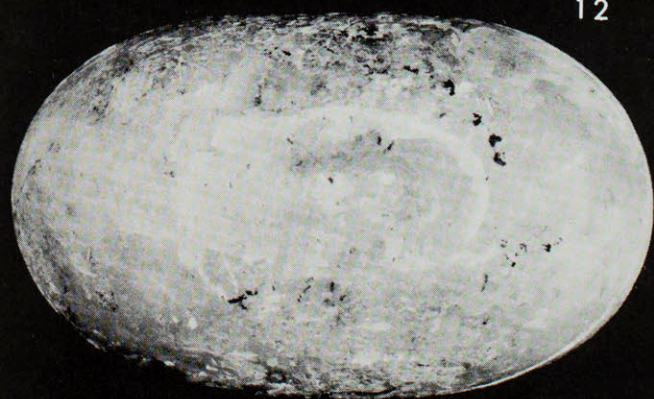
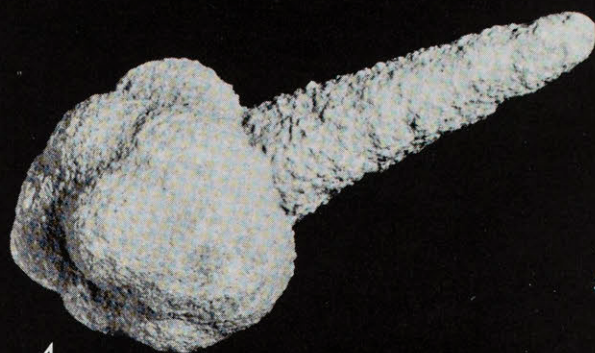
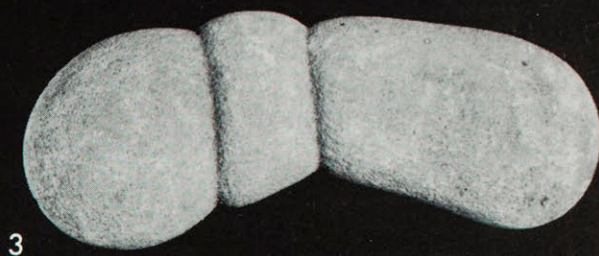
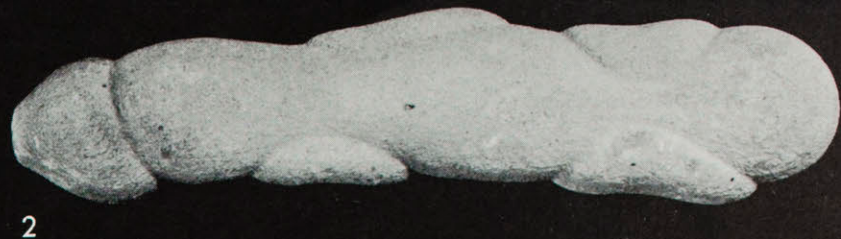
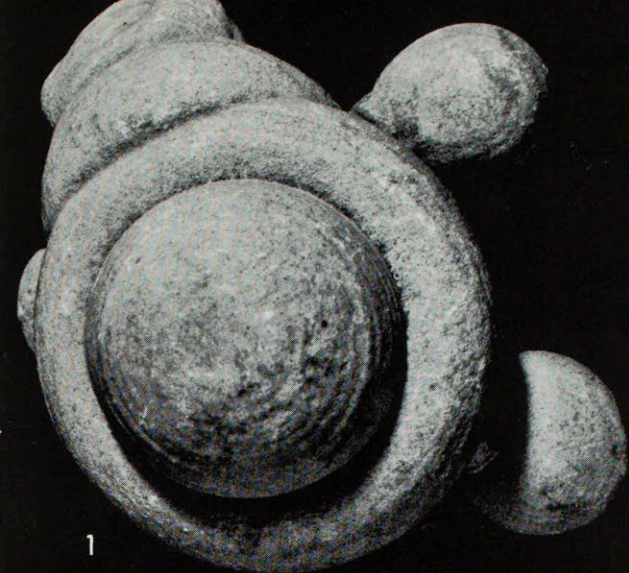
1. If concretions are too close while they are forming, they will coalesce like this specimen from the Salton Sea area of California.

2-5. Concretions may be shaped like anything or nothing you ever saw before. 2 and 3 are from the Seventeen Palms, California area and 4 and 5 are from southern Imperial County, California.

6-8. These concretions from New Hampshire are very boogaloo.

9-11. Concretions can resemble bones, brains, or bird eggs. We do not know where these were found.

12-13. Concretions have a concentric structure internally, as seen in this one found east of Palmdale, California. It is shown before and after splitting. The differences in layering indicate a complex history.



13



fat plant roots or funny biscuits lying parallel to the bedding planes of the host rock. They are sometimes spherical and sometimes grown together in irregular sheets. Nodules are usually rather small. For example, large spherical ones are generally about baseball sized, but a few giants would make swell rock cannonballs. They usually are found in marine limestone and are made of silicate minerals called chert or flint.

Unlike true concretions, they generally do not show a concentric structure and generally replace rather than incorporate most of the grains of the host rock.

Many of the mountain ranges along the highway between Los Angeles and Las Vegas have limestone beds with abundant chert nodules. If you stop in one of the passes where you see some "layer cake" looking rock formations in the hills, you will likely find that some are limestone beds with chert nodules in them. Only rarely are they very interesting looking, though.

Geodes are accretionary structures that are usually subspherical in shape and may range in size from about 1 inch to as much as 5 feet in diameter. They are characterized by being formed in holes that were later partly or wholly filled by minerals, usually silicates. The holes may have been once occupied by fossils if they are in sedimentary rocks like limestone. Holes in volcanic rocks were formed by gas bubbles when the rock was hot. Like many nodules, geodes are not very interesting on the outside, being kind of egg shaped, and indeed some are known as "thunder eggs." They are usually collected for the beautiful minerals inside, some geodes having nests of glittering crystals. Apple sized geodes that are quite beautiful occur in ancient lava flows exposed in the seacliffs of the Palos Verdes peninsula near Marineland. One of the nicest collecting areas for geodes is around the town of Prineville in Crook County, Oregon, where the Chamber of Commerce has thoughtfully staked out almost 1000 acres of mining claims just to make free digging available to the public.

Septaria are globular shaped rocks that are criss-crossed by series of radiating cracks filled up with a mineral

such as calcite. Some are thought to have formed rather mysteriously on the ocean floor as bodies of aluminous gel that eventually hardened on the outside. The interior was then supposed to have dehydrated and shrunk, causing the cracks to develop. The septaria were then buried and later, after the sea floor had become land, weathered out for you to find.

Septaria have sometimes been mistaken for turtles because the crack patterns make them look like turtle shells. They also come in about the same sizes as turtles. One super specimen that I once saw looked much like a heart, complete with coronary arteries.

Septaria aren't common at any easily reached localities in southern California, but we do have some in the museum collections from the Santa Monica Mountains and from Inyo County.

There are other kinds of accretionary structures, but the ones covered here seem to be of most general interest. All of them are great items to look for because you can be outside doing a big nature thing and using your imagination instead of a tedious book for identifications.

I'd love to admire any concretions you find and want to show me. But please don't ask me to save your giant clams.

Dr. Edward C. Wilson is curator of invertebrate paleontology at the Natural History Museum. He is a specialist on Permian corals and has published several articles on these and other invertebrate fossils.

Concretions, a geode, a septarium, and chert nodules from our museum's collections, all shown slightly smaller than the actual specimens.

1-5. Near Las Vegas, fantastic little animal cracker like concretions occur. Collect-

ing and identifying them can be fun. 1 might be a howling dog, 2 a seal peering over his shoulder, 3 some giraffy animal, 4 a bodyless camel head, and 5 a headless camel body.

Know a good dating service for 4 and 5?

6. Some concretions formed about nuclei that may be real fossils. The famous Mazon Creek, Illinois ones are known especially for the lovely plant fossils that show when they are split.

7-8. Geodes are not very interesting on the outside, but some show linings of glittering crystals like this one from Keokuk, Iowa if they are broken open.

9. Septaria are globular shaped rocks criss-crossed by mineral filled cracks. Some resemble turtles and I once saw one that looked like a heart. We do not know where this rather ordinary one was found.

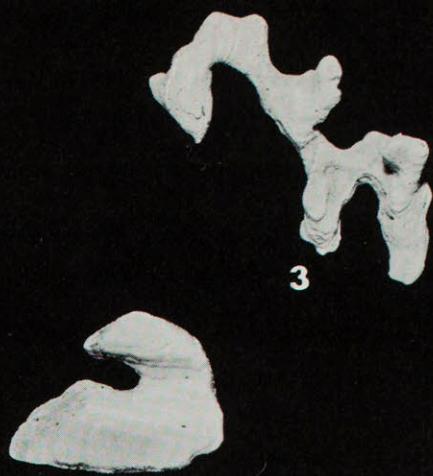
10. Nodules are made of chert or flint and usually occur in marine limestones. They can be found in many of the desert mountains between Los Angeles and

Las Vegas. This one, from near Las Vegas, is still in the limestone.

11. This nodule is from the same place as the one shown in 10, but it has weathered free of the limestone. It has an interesting form, although most nodules are rather dull.



1



2



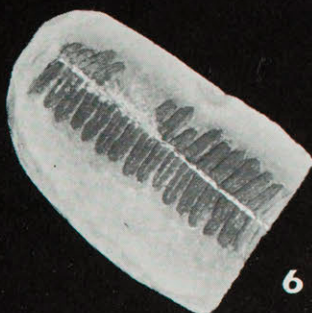
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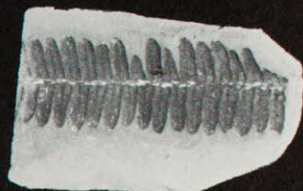
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7



8



9



10



11

Living On a Coral Reef

Nine Fathoms Under

by Sylvia A. Earle

*Roll on, thou deep and dark blue ocean,
roll!
Ten thousand fleets sweep over thee in
vain;
Man marks the earth with ruin,—his
control
Stops with the shore.*

— Lord Byron

Or does it? More than three quarters of the world has never been inhabited by human beings, most of it underwater. But this may change. Early in 1970, a century and a half after Byron's sanguine verse appeared, 62 scientists and engineers were selected to participate in an ambitious experiment in underwater living.

It was named the Tektite II Project, for the program followed the successful completion of Tektite I, involving four scientist-aquanuts who lived underwater for a record-breaking two months during 1969. During Tektite II, several teams of four scientists and one engineer used the small but comfortable four room Tektite habitat as an underwater laboratory and home for periods of 14 to 30 days, and made daily excursions through a round blue hole in the floor to a more significant habitat beyond, the ocean itself.

The site of the experiment was the Caribbean Sea, in Lameshur Bay, St. John, Virgin Islands, selected because of the area's biological diversity and clear, warm water. The depth: 50 feet, with excursions possible between depths of 20 and 100 feet.

The objectives were several. A basic goal was to establish that saturation diving from an underwater base can be done efficiently, safely, and at relatively small cost, using a breathing mixture of nitrogen and oxygen. The General Electric Company tackled the engineering problems, for they were the builders and designers of the habitat and a new closed cycle breathing system that was used during Tektite II.

A second objective was to study and evaluate individual and group behavior of the aquanuts. This was the area of greatest interest for the National Aeronautics and Space Administration, who hoped to gain a better understanding of factors affecting crew behavior and performance for space missions by observing aquanuts working in isolation underwater. Each Tektite team was under constant surveillance by closed circuit television and open microphones, with activities continuously recorded, later analyzed, and correlated with background information supplied by testing and life history information.



Related to the behavior studies were careful biomedical observations. Extensive testing was carried out during Tektite I with the conclusion that there were apparently no adverse effects incurred during long periods of operation at a depth of 50 feet. Therefore only limited medical studies were made of teams working at 50 feet during Tektite II.

The most significant aims of the project were scientific. There have been other underwater habitats, some stationed deeper, and some keeping occupants underwater for longer periods of time, but the Tektite program was the first designed to fit the needs of scientists, and to have scientific research as a major objective. Those who applied to participate as aquanauts were selected primarily on the basis of proposals submitted that outlined how time underwater would be used to accomplish a specific project. Secondary considerations included diving experience and good physical health — necessary qualifications, but not as significant as having sound scientific justification for going.

The Tektite Project was also the first nationally sponsored program to accept women as aquanauts, and I was designated leader of five selected for two weeks of submergence during July, 1970.

A group effort sent us down. Numerous government agencies, foundations, universities, and private companies supported the Tektite program. The Department of the Interior served as the lead agency, and program director, Dr. James W. Miller, ably coordinated the diverse activities and aims, sometimes from a desk in Washington, but more often from the Tektite base camp located a short distance from the shore of Lameshur Bay. All would-be aquanauts reported to base camp for two weeks of training prior to the actual mission, and after two weeks, all welcomed the prospect of exchanging mud, mosquitoes, cold showers, and institutional food for life in the habitat. The habitat featured a freezer stocked with frozen dinners (including steak, spinach souffle, and lobster Newburg), carpets on the floors, an air conditioned atmosphere, hot shower, clothes dryer, and most importantly, ready access to

the reef, and unlimited diving time.

Aquanauts spent much of their training period learning to use General Electric's new closed cycle diving apparatus, the rebreather, a device that recycles air through a closed system, removing carbon dioxide by passing the air through a canister of baralyme, and adding oxygen as needed. Advantages of the system over open circuit equipment include time (rebreathers can be used continuously for more than six hours, while a single scuba tank is usually consumed in less than one hour), and the fact that no bubbles are produced, thus no noise, and no moving column of silver spheres. For behavior studies on marine organisms these features are of particular significance because it is possible, with a rebreather, to glide among reef inhabitants with minimum commotion.

During the various missions, chemical, geological, and biological studies were conducted. John Vanderwalker and Ian Koblick, using an ingenious tagging technique, discovered much new information about the habits of the spiny lobster. Richard Curry and Roger Dexter, who made detailed chemical analysis, discovered that measurements of oxygen in seawater samples may be in error when tested in the usual manner at the surface, a situation that can be corrected if samples are processed at ambient pressure. The reaction of fishes to fish traps was observed by William High and Alan Beardsley with some surprising results. For example, they concluded that the position of a trap on a reef may be more important than the kind of bait used, and after a certain number of fishes have entered a trap, there will be no appreciable increase, no matter how long the trap is left on the bottom. The effects of marine organisms on building and modifying reef structure was studied by H. E. Clifton and Ralph Hunter, and others concentrated on bio-acoustics, habits of octopuses, behavior of fishes, the effects of pollutants on reef dynamics, and more.

One of my teammates, Dr. Renate True, studied the day-night oxygen cycle and small invertebrates associated with a bed of the sea grass, *Syringodium manatorum*, and compared these data with similar information

taken from a small patch of artificial sea grass that she planted during the pre-dive training period. Two others, Mrs. Ann Hartline and Miss Alina Szmant, in collaboration with Dr. Peter Hartline and Arthur Flechsig (working from the surface) studied the escape responses of the blue *Chromis* (*Chromis cyaneae*), by observing and filming the fishes' reaction to models of several sizes and shapes that were drawn at various speeds along a wire over the reef where the fishes hovered.

My work concerned the influence of grazing fishes on the attached vegetation, a project that involved much looking to determine what fishes were eating what plants, and when during a 24 hour cycle the grazers were active. In collaboration with members of a previous Tektite team, Dr. Arthur Mathieson and Mr. Richard Fralick, two transect lines were established seaward from the reef. Several cages made of hardware cloth were placed at intervals along the transect, and an inventory was made of numbers and kinds of plants and fishes that occurred along the lines. Growth was observed inside the cages (protected from grazing activity) and compared with adjacent exposed areas. Results supported the findings of Randall (1961, 1965), who studied grazing activity in several tropical reef areas and concluded that the striking paucity of reef vegetation and a conspicuous bare area immediately surrounding many reefs is the result of heavy inroads made by plant-eating fishes. The observations that I made certainly suggest that this is the case in Lameshur Bay. Schools of grazing fishes (I was more inclined to think of them as herd or flocks), usually consisting of one to three species of surgeonfishes, one to three species of parrotfishes, and sometimes goatfishes and an occasional queen triggerfish, foraged along the reef and nearby algal flats, seldom venturing more than 100 feet from the reef, and never observed more than 200 feet from cover.

During the second day underwater, one of the small grazers that I had been watching, a bicolor damselfish, began to pay particular attention to a blade of green algae attached to a chunk of limestone. I looked and found that the

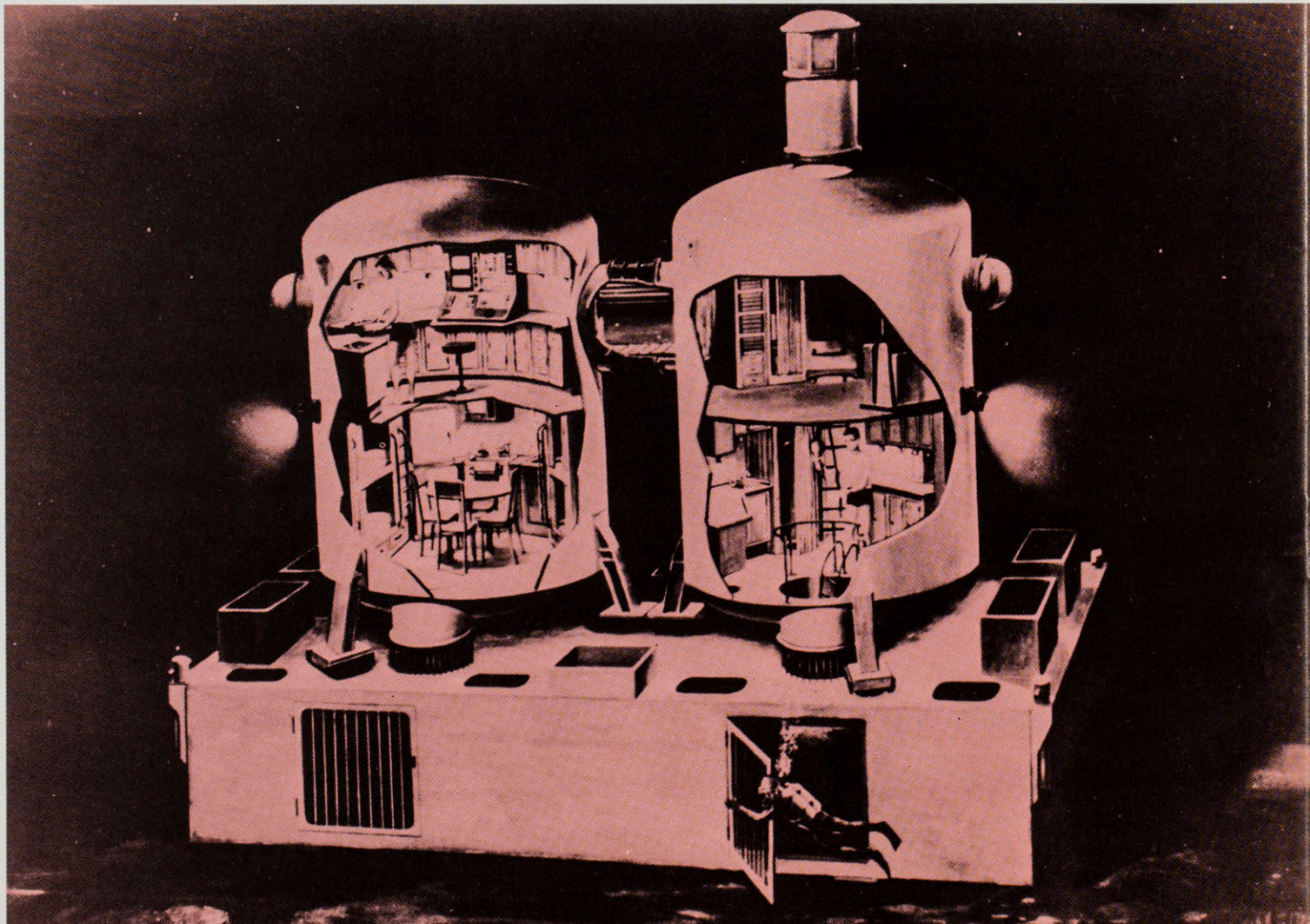


Great Lameshur Bay,
St. John Island, U.S.
Virgin Islands, the site
for the seven-month
Tektite II Program.



Diagram of the Tektite
habitat, showing the four
compartments with
connecting tunnel.

Base camp, whimsically
known as "that tropical
island paradise" where
aquanauts trained and
support personnel lived
during the Tektite
program.



blade was covered with about 100 oval, translucent eggs, and thus began a compelling distraction that ultimately involved all members of the team. At least once a day thereafter, the damselfish and its companions on that rock were watched, and samples of the eggs were taken back to the habitat for microscopic study, drawings, and preservation. It was a rare opportunity to watch the *in situ* development of eggs and the breeding behavior of fishes living in 70 feet of water, a study that would have been difficult without access to an underwater laboratory.

We were pleased with the results obtained during the two week period, and although we wished for more time, actually came away with more information than we had expected. We were surprised, as well, not only about the quantity of information gathered, but also the kind. With long periods of observation, uninterrupted by returns to the surface, all of us began to see things not noticed during quick in and out visits. This is one of several distinct advantages that saturation diving offers over other techniques for getting underwater.

The most obvious advantage is simply time. A diver working from the surface is usually limited to 90 minutes at a depth of 50 feet before decompression is required. Decompression time varies, depending on the length of time compressed gases have been breathed at depth, but once saturated, decompression time is the same, no matter how long the depth is maintained. Decompression for the Tektite teams took 20 hours, but would have been the same if they had remained for a year.

Unlimited diving time means that for the first time it is possible to consider a working day underwater comparable to a day on land. Despite long safety preparations prior to each dive, and need for many hours actually in the habitat for eating, sleeping, writing, and laboratory work, it was often possible to be in the water for seven or more hours a day. My total diving time during the 14 day mission was 88 hours, more than half spent at depths greater than 50 feet. That would have taken at least two months to accomplish working from the surface, diving every day under

the most favorable circumstances.

Scientists on land have always taken for granted the ability to enter the woods or hills of their choice for study, but underwater, even simple operations can become enormously complicated, in part because of stringent time limitations. Saturation diving enables scientists to conduct *in situ* experiments and observations with a schedule that fits the problem, instead of having to choose a problem that fits a tight diving schedule.

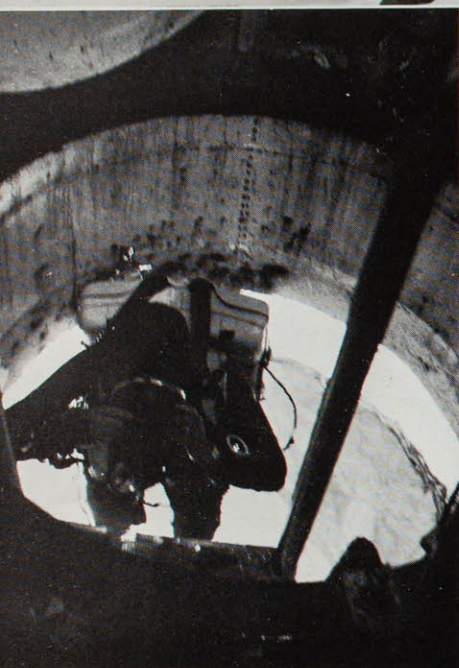
Another important advantage of saturation diving is a phenomenon that I call the "total immersion effect." When committed to an extended period of time underwater, with clearcut objectives, few outside distractions, and simplified living chores, a situation is created that is conducive to maximum productivity. Days during the mission were characterized by high, good spirits, enthusiasm for the work being done, minimum sleep, maximum accomplishment. The atmosphere resembled that of an oceanographic expedition, all members intently doing work they cared about, remote from the usual human involvements. During a sample day, our fourth underwater, engineer Peggy Lucas and I got up well before daybreak and together went through the check out procedure for a dive using double scuba tanks. At 5:15 a.m. we stepped into the blue pool of water in the floor of the wet room and with hand-carried lanterns lighting the way, glided over the reef to a site 700 feet from the habitat in 70 feet depth. Three objectives were uppermost: to observe and time the emergence of garden eels from their burrows, to observe the breeding damselfishes, and to watch the behavior of grazing fishes. We took notes and photographs, collected several plants for later examination, and after a couple of hours returned to our underwater home for breakfast. After the specimens were labelled and notes from the slate recorded, we began preparation for the next dive. This took nearly two hours, including time for numerous exchanges with watch personnel on the surface. Approximately noon, immediately after aquanauts Ann Hartline and Alina Szmant returned from their morning work, Dr. True and I departed with rebreather units for the

site of Dr. True's artificial sea grass bed, 1000 feet north of the habitat. We returned at mid-afternoon, and there Dr. True stayed to process oxygen samples and sort through the microfauna gathered from the sea grasses. Hartline and Szmant prepared for an afternoon at their experimental site, and engineer Lucas and I slipped on scuba tanks for a swim along my transect line. We returned at 4:00 p.m., and thirty minutes later I departed again, this time with Ann Hartline, for additional observations along the same transect. We returned to the habitat for a late supper, cleaned and put away equipment, transcribed notes, wrote letters, and examined specimens, amid much clowning. There were taped television programs to watch, racks of taped literature, and many other diversions thoughtfully selected and provided by NASA for entertainment, but most of the teams, ours included, took pleasure in the unique circumstances, and except for mail, seldom sought to be reminded of surface affairs, even for entertainment. Peggy Lucas made a game out of changing the habitat's baralyme; Renate True frequently entertained herself far into the night watching the antics of her microbeasts under a microscope. All of us spent much time leaning out of the habitat's hemispherical ports to watch outside activity from a dry perch. Taped music was a source of great pleasure, but there was neither time nor desire to watch television or read about someone else's real or imagined adventures with so much live action going on around us. Films were no competition for the three large silver tarpon that circled the habitat at night, feeding on schools of small jacks that were attracted to the lights, or the view of a full moon through 50 feet of clear reef water.

In addition to time and the "total immersion effect", another aspect of saturation diving that can be enormously valuable to scientists is the perspective that comes with underwater living, the viewpoint of a resident. Sampling a reef with nets and dredges may give some idea of what the components are, but give no insight into what they do or how they interact. Photographs and television monitoring may give



Mission 6-50 aquanauts being briefed on use of new rebreather units.



An aquanaut leaving the habitat for a swim using a rebreather unit.



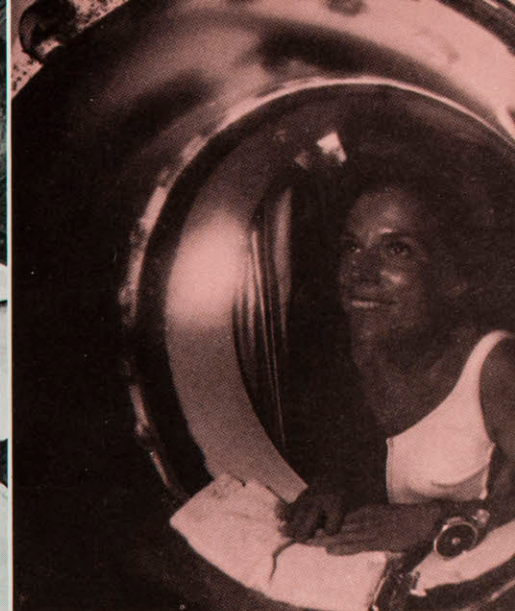
Dr. Renate True collecting samples of artificial sea grass to determine what microorganisms have settled there.

The crew quarters, with bunks and galley.

Gray angelfishes often greeted Tektite aquanauts on the reef.



Dr. Sylvia A. Earle looking through a port of the habitat.



Small snappers lived on the reef and frequently swam near the habitat.



Fishes grazing on algae attached to the habitat's exterior. Similar groups of parrotfishes and surgeonfishes browsed on plants close to the reef.



Garden eels, shown here half emergent from their burrows, were frequently observed during the mission.



Women aquanauts wearing rebreather units, at the cupola of the habitat.



additional information, but details are missed, and the view is necessarily limited to a small area. And the diver entering for a one hour swim comes as a visitor, with insufficient time to become well acquainted or to follow a full day's activity.

Aquanuts in Lameshur Bay came to know individual plants, fishes, queen conchs, lobsters, starfishes, and others, particularly those that occupied specific crevices or burrows and thus could be easily found and identified. Animals took little notice of our presence, particularly when rebreathers were used, and within a short time we came to regard ourselves, and perhaps to be regarded, as members of the reef community. During Mission 6-50 we made a special effort to look at activity during all hours, day and night, but emphasized dawn and dusk because these times mark dramatic change. At day-break, night creatures abruptly head for cover, and animals active during the light hours emerge from whatever protective place they have occupied through the night.

At night we frequently swam side by side with the tarpon as they fed, apparently without interrupting the fishes' normal activity, and often came close to a school of great amberjack that patrolled the reef near the habitat. By day, gray angelfishes were so unconcerned about our presence that they often swam close, occasionally nibbling the string of my collecting bag and even wisps of my hair. The ability to move about without causing alarm was of critical importance to those observing animal behavior, and was instructive to all.

As reef residents, aquanuts literally begin to "think like a fish", to begin to see what influences life on a reef on a day to day basis, and through long, careful observations, to perceive interactions among individuals living on the reef. Patterns of activity become apparent, and interrelationships among the plants and animals present start to make sense. For example, I began to speculate on the influence large predators may have on marine vegetation. Sharks, barracuda, groupers, and snappers are but one step away from the bottom of the food chain when they feed upon surgeonfishes, parrotfishes,

and other plant-eating species, which they often do. If large predators are selectively removed through fishing by humans, it follows that the fishes normally preyed upon should increase, and that in turn the food these fishes depend upon will be reduced. It is a familiar pattern on land. When cougars, wild cats, wolves, and coyotes are killed, deer and rabbits increase, and the vegetation upon which the grazers feed diminishes. When hawks and owls are eliminated, rodents abound, and more seeds, roots, and fruits are consumed. I am not yet prepared to draw underwater analogies, but it is clear that removal of predators from a community will result in change.

Preliminary reports are now in for all of the Tektite missions, and the results are impressive. The behavioral studies indicate high correlation between performance and personal characteristics ascertained by testing and questionnaires, which suggests that crews for work in isolation can be screened more effectively than in the past. Moreover, saturation diving was shown to be feasible for almost anyone in reasonably good health. Unlike exploration of space, that necessarily will be the privilege of a select few for many years to come, the seas are available to virtually everyone. Diving is not particularly strenuous, despite the popular image that an aquanaut must be large and muscular. Being a 110 pound female proved to be no disadvantage for any operation during the Tektite program.

From an engineering standpoint, the program was a success, and much was learned that will be useful in designing and building future underwater structures. The total cost of the program, approximately three million dollars, compares favorably with the expense of operating a research vessel, and is miniscule relative to budgets for space efforts.

But perhaps the most significant accomplishment of the program was the convincing demonstration that saturation diving from a habitat is a safe and practical research technique for underwater exploration, with several unique advantages. Habitats may have a useful potential comparable to oceanographic expeditions operating on the

surface, the habitat serving as a center from which mobile field operations can be conducted, and to which parties can return for living and working. They may be used as marine stations, where classes can be conducted for several weeks at a time, but with far greater opportunity for learning than when remote from the environment being studied. Perhaps habitats will be used for sea farming, for mining, and even for vacation resorts. But for the present, the technique will serve primarily as an important new approach to underwater exploration. Much has been learned from ships, and from shore-based laboratories. New insight came with the development of scuba and various submersibles that actually put people in the water for direct observation and work. Underwater habitats represent a logical next step, the reasonable approach to exploring and coming to understand the aquatic environment.

As awareness grows of the economic value of a healthy environment, there will be a clamoring for more sound information, not just speculation, about what constitutes a healthy bay, or what happens when pollutants are introduced into a lake or sea. Habitats may be used as fixed or mobile bases for rapidly assessing an underwater site, or for monitoring selected areas on a long term basis. The immediate need is urgent for basic information as well as documentation of change attributable to human activity. What effect will undersea mining have on the marine environment? What influence does dredging and filling have on shallow-water nursery grounds for fish and shellfish? What difference does it make to marine organisms if bargeloads of garbage are routinely dumped at sea? At present, no one really knows. But underwater habitats provide a method for finding answers. The development of an important new technique has come none too soon, and with luck, its use will not be too late.

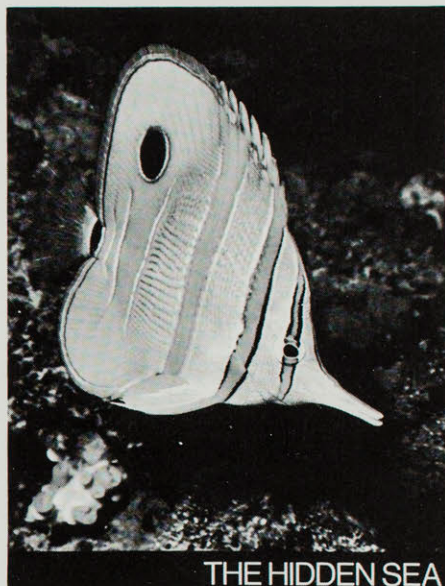
Dr. Sylvia A. Earle is research associate in Botany at the Natural History Museum of Los Angeles County, the University of California at Berkeley and Farlow Herbarium, Harvard University. She has published widely in the field of marine botany and was a 1970 Los Angeles Times Woman of the Year.



Book Review

The Hidden Sea

By Douglas Faulkner
(photographs and notes)
and C. Lavett Smith (text).
A Studio Book,
The Viking Press,
New York, 1970. \$14.95.



"This book is dedicated to beauty in the world of nature." To say merely that the 68 large-page colored plates (some on two-page spreads) are superbly beautiful is almost an insult. They comprise a diverse sampling of the masterpieces of a renowned undersea photographer. The first 12 pictures display a resplendent miscellany of marine creatures, from Gloucester, Massachusetts, Florida, Japan, and varied tropical waters. This section is accompanied by an orienting essay, by coauthor Smith, condensing in six pages for the general public an array of pointed information on life in the sea. Following are six to eight colorful portraits each of sponges, corals, mollusks, crustaceans, echinoderms, fishes, cleaning symbionts, and dangerous marine animals. Each of the nine sections, in turn, is accompanied by four meaningful pages of text to enlighten the reader on the animals comprising the given group or subject. The final 24 pages, by Doug Faulkner, give for each picture, alongside a reduced black-and-white duplicate, the title, identification, size, locality, distance, and date; then a few interesting remarks on the species or group represented.

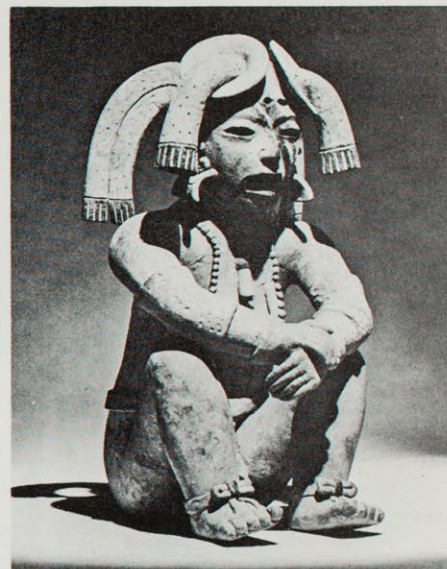
Selecting particular subjects for note is not easy, but I can not refrain from mentioning a few. Revealing and concealing colorations are dramatically

contrasted by the facing pictures of an anemonefish and the sargassumfish. The Formosa jellyfish puts an artist's imagination to utter shame. Other eye-catchers are views of a chambered nautilus head on; a pair of cuttlefish in colorful nuptial embrace; a cleaner shrimp deparasitizing a fairy bass; a radiant slate-pencil urchin; various coral-reef fishes painted beyond an artist's capability; a variety of cleaner fishes grooming spellbound larger fishes which one would rather expect to be their predators; and a crown-of-thorn starfish, which by its beauty seems to belie its devastation of coral reefs.

The whole book is an entrancing and informative portrayal of the profuse and fascinating life that exists within the shallow waters of the sea, largely "hidden" to be sure, but now readily accessible by skin diving and scuba. This superb book will be an inspiration, to novice and veteran alike.

CARL L. HUBBS

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